IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of:	) Confirmation No.: 7432
Giridhari L. Agrawal	) Examiner: Justin M. Krause
for: HIGH LOAD CAPACITY FOIL THRUST BEARINGS	) Group Art Unit: 3682
Serial No.: 10/608,970	) (Atty. Docket No. 4525-0009)
Filed On: June 27, 2003	)

DECLARATION UNDER 37 C.F.R. § 1.132

I, Dr. Giridhari L. Agrawal, do hereby declare and state as follows:

1. I am the sole inventor of the invention disclosed and claimed in U.S. Patent Application Serial No. 10/608,970 (hereinafter "the Application"). I have reviewed and am familiar with the Application, including the claims as amended March 22, 2007.

2. I am the founder and President of R&D Dynamics Corporation, which was formed in 1990. My responsibilities include overseeing all research, design, engineering and manufacturing of R&D Dynamics' products and concepts.

3. R&D Dynamics is a world leader in research, development and manufacturing of air bearing supported, oil-free high-speed turbomachinery. Presently, every aircraft, civil or military, built in the last 25 years uses the technology developed by me, Dr. Giri Agrawal.

4. I have a Bachelor of Science, Mechanical Engineering, from the University of Bihar, India, 1958; a Master of Science, Structural Engineering, from the University of Colorado, USA, 1963; and a PhD, Mechanical Engineering, from the University of Colorado, USA, 1968.

5. I have over 30 years of experience in the rotating machinery field, including familiarity with high-speed turbomachinery and foil journal and thrust bearing technology used therewith. My experience includes:

- From 1990 to the present at R&D Dynamics Corporation, of Bloomfield, CT, USA. I am President and Chief Engineer. Under my leadership, R&D Dynamics has become a recognized world leader in foil air bearing technology. Since R&D Dynamics' founding, I developed and patented (or having patent pending for) the third generation of foil bearing technology, a dynamic foil face seal for the next generation of gas turbine engines and a turbocompressor for fuel cell applications.
- From 1979 to 1991, I was Chief Project Engineer at Hamilton Sundstrand, Windsor Locks, CT, USA. I was responsible for all rotating machines using fluid film bearings including foil gas bearings. I developed many environmental control systems and air cycle machines including B-747, L-1011, B-1B, B-2, M-1 Tank, F-18 F/T, and Test Bed II.
- From 1971 to 1979, I was a Senior Engineering Specialist at AiResearch Manufacturing Company (now Honeywell) in Torrance, CA, USA. I designed and developed many rotating machines using process fluid bearings (air as well as other fluids). These include the NASA Nuclear Brayton Turbo Alternator Compressor, the NASA Mini Brayton Rotating Unit, the JFS-100, many foil gas bearing air cycle machines (including those used on the A7E, F-18, F-15, Cessna 550), a fuel cell turbocompressor, the GRI sub atmospheric gas turbine, many sizes of solar heat pumps, the Los Alamos Scientific Laboratory compressor, a heat recovery system, and hot end auxiliary power unit bearings.

6. I have been awarded the following U.S. patents directed to bearing technology:

- U.S. Patent No. 4,348,066 to Agrawal et al., entitled "Foil Bearing Mounting";
- U.S. Patent No. 5,634,723 to Agrawal, entitled "Hydrodynamic Fluid Film Bearing";
- U.S. Patent No. 6,948,853 to Agrawal, entitled "High Load Capacity Stacked Foil Thrust Bearing Assembly";
- U.S. Patent No. 7,070,330 to Agrawal, entitled "Hydrodynamic Fluid Film Bearing Having A Key-Less Foil";

- U.S. Patent No. 4,462,700 to Agrawal, entitled "Hydrodynamic Fluid Film Thrust Bearing";
- U.S. Patent No. 4,415,280 to Agrawal, entitled "Hydrodynamic Fluid Film Bearing";
- U.S. Patent No. 4,415,281 to Agrawal, entitled "Hydrodynamic Fluid Film Bearing"; and
- U.S. Patent No. 4,747,705 to Agrawal, entitled "Power Shaped Multipad Hydrodynamic Journal Bearing".

7. Based on my experience and expertise in the field, it is my opinion that a well known problem with conventional thrust bearings, specifically annular plates used in the bearing assembly, is that they deform from a flat to a cone-shaped configuration and are susceptible to waviness distortions. This deformation and distortion can happen at the time of manufacturing such as heat treating, welding of foils, or during the bearings' service life. Air film thickness during operation is of the order of 0.0001 inch thick. Hence slight distortion of the foil plate affects the load capacity, wear and service life. It is essential that the foil plate be kept flat. Keeping the bearing flat ensures that the hydrodynamic wedge between the stationary top foil pad and the rotating runner is properly formed during bearing operation.

8. My invention, entitled "High Load Capacity Thrust Bearings" and the subject of the Application, is directed to solving problems with conventional thrust bearings in the field of high-speed turbomachinery that have persisted for over 30 years. The deformation and waviness distortions that are prevalent in current thrust bearings are absent in "High Load Capacity Thrust bearings" because the lines of weakness in the annularly shaped base plate relieve the internal stresses that cause deformation and waviness distortion.

9. I have reviewed the following references cited by the Examiner in the Office Action dated May 30, 2007:

- U.S. Patent No. 6,224,263 to Saville et al., entitled "Foil Thrust Bearing with Varying Circumferential and Radial Stiffness";
- U.S. Patent No. 4,682,900 to Gu, entitled "Thrust Bearing Underspring"; and
- U.S. Patent No. 5,833,369 to Heshmat, entitled "High Load Capacity Compliant Foil Hydrodynamic Thrust Bearing".

I have also reviewed patents referred to or incorporated into the cited references, including:

- U.S. Patent No. 4,624,583 to Saville et al., entitled "Foil Thrust Bearing" and referenced in Saville et al.'s '263 patent; and
- U.S. Patent No. 4,247,155 to Fortmann, entitled "Resilient Foil Bearings".

10. The Saville et al. references disclose an annularly shaped thrust bearing disk with a plurality of integrated bearing pads, or foils, circumferentially positioned about the entire surface of the disk. A plurality of slots are included in the disk between the pads for allowing a substantially unrestricted flow of fluid to pass through the thrust bearing disk to form a fluid film between the disk and the thrust runner surface. One of ordinary skill in the art would recognize that the slots also allow the trailing edge of each pad to be compliant under operating conditions. In my opinion the slots are not provided to maintain flatness in the thrust bearing disk since the disk is not flat to begin with. Further one of ordinary skill in the art would recognize that transition areas and ramps are required in the Saville et al. design because the pads are integral with the disk, because slots have been included about the trailing edge of each pad to make the integrated pads compliant, and because such ramps are needed to maintain rigidity (stiffness) in the disk to accommodate the compliancy of the pads. In my opinion, one of ordinary skill in the art would not alter the Saville et al. designs to utilize a flat bearing disk, considering that the pads are taught as being integral with the disk so as to eliminate the need for a plurality of individual foils, because, inter alia, the focus of the Saville et al. invention to one of ordinary skill is to balance the compliancy of the integrated pads with the rigidity of the disk.

11. The Gu patent is generally directed to the design of an underspring for use in a thrust bearing. Based on my review, Gu does not show or teach a flat thrust bearing plate or a flat underspring plate respectively having a plurality of foils or springs thereon and including a plurality of decoupled bearing segments circumferentially arranged about the plate and defined in part by a plurality of generally radially extending lines of weakness circumferentially dispersed about the plate. Gu illustrates a conventional thrust bearing disk having a plurality of individual foils, but no means for including a plurality of decoupled bearing segments in the thrust bearing disk. The disclosed underspring is not flat inasmuch as the Gu reference discusses including bumps to provide stiffness to the thrust bearing disk. Gu refers to the Fortmann reference, which does not include a plurality of individual foils, but instead integrates the foils into the thrust bearing disk.

12. The Fortmann patent, referenced in Gu, was issued on January 27, 1981 and assigned to United Technologies Corporation ("UTC") in Hartford, Connecticut. I was employed by UTC at that time period and am familiar with Mr. Fortmann and his work with resilient foil bearings. Fortmann created "lines of weakness" in the top foil portion of the hydrodynamic fluid bearing to purposely create deformation to establish the hydrodynamic fluid film wedge, the holes added to the top foil also aided in cooling and circulating air within the bearing. The lines of weakness or slits in my invention "High Load Capacity Thrust Bearings" simply prevent deformation from happening in the first place.

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the Application or any patent that issues therefrom.

July 27, 2007
Date

Giridhari L. Agrawal
Name: Giridhari L. Agrawal

Attested to:

Wm. Tucker Griffith
Registration No. 44,726
on July 27, 2007